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Compressive strength evaluation of Human hair and Polypropylene fabricated reinforced composite

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----------**ABSTRACT**----------
With the rise of population the uses of conventional and non-conventional resources are highly increased. As we know the resources available are limited to their origin but the uses also may not be affected as well according to their importance. There are some resources like natural fibres have not come under proper attention in passing years, even some of which like human hair are destroyed as a waste material. But after knowing better sides of these fibres, they are getting a proper attention over the years. With the aim of utilizing abundant waste material, a human hair composite has been developed using human hair as reinforcing constituent and polypropylene as matrix constituents. This paper presents fabrication and properties evaluation of human hair reinforced polypropylene composite. Composites with various compositions of human hair and polypropylene were fabricated. The composite with human hair came out to be better for reinforcement among various composites. The fabricated specimen composed of various % of human hair in polypropylene is tested for properties improvement and came out as an eye opener. The mechanical properties are highly improved and results are properly evaluated and analysed.

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I. INTRODUCTION

Composite is the combination of two or more materials in which one is reinforcing element while other is matrix element. The selection of two materials for composition is a complicated task itself and selected according to their properties and uses. After that, effectiveness of composition obtained by selected materials comes under the consideration. The properties of composite are also depend upon the individual properties of selected materials. In present paper the selected materials are human hair and polypropylene which is derived from polymer. Polymer is available in two forms as thermoplastic and thermosets in phase of PE, PP, PEEK, PVC, PS, Polyolefins etc and epoxy, polyester and phenol-formaldehyde resin etc respectively used to reinforce different fibers according to their application. [1-2]

The hair fibre is made by keratin protein and having alpha-helix structure. It contains about 91% of protein as amino acid linked by peptide bond. The average hair contains the 45.68% carbon, ,27.9% oxygen, 6.6% hydrogen ,15.72% nitrogen and 5.03% sulphur. These contents of hair fibre enable it with many vital properties such as good strength, high toughness, biodegradability and some other mechanical properties. Beside these advantageous properties there are some disadvantages also comes under the attention. These are poor resistance to moisture, finite length and large diameter incorporate a challenge over the advantageous use. [3-5].
In this paper the human hair fibre is added in various % in polypropylene for their properties evaluation and comparison with their individual properties. The composition is prepared using injection moulding machine and holding on above 200^0C and after some time the mixture is cooled and removed from the machine for further tests. [6-8].

II. EXPERIMENTATION

The section of experimentation comes after the, fabrication of composites with the help of injection moulding machine. The machine is provided with its simple specifications and various useful components. The fabrication is proceeded in a specific pre-decided manner that means the composition aspect of human hair and polypropylene. There are various % of human hair which is supposed to incorporated with the appropriate % of polypropylene. We obtain three composites with the addition of suitable % range of both the materials using the specified machine.
These composites are as :
Composite 1 with 3% HH and 97% PP

Composite 2 with 5% HH and 95% PP
Composite 3 with 8% HH and 92% PP
(HH- human hair, PP- polypropylene)
The composites obtained from injection moulding machine are in the form of specimens as shown in figure 1

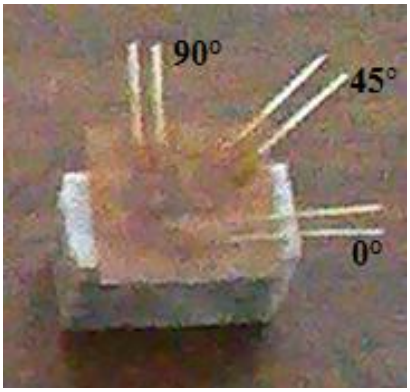

Fig 1 Specimen obtained from injection moulding machine

These three composites are used for experimentation purpose and their properties are well compared and suitably observed for properties evaluation as compressive strength. Avoiding more tables and calculations as space point of view only one consideration of Composite 1 is shown in present paper and results obtained for both of remaining by performing similar test is properly mentioned. Experimental observation of composite 3 is given in Table 1.

Table 1 Experimental observation of compressive test for Composite 1

Load P (N)	**Elongation δ (mm)**	**Linear Strain, ε_x (x10^{-6})**	**Strain at 45° ε_{45} (x10^{-6})**	**Lateral Strain, ε_y (x10^{-6})**	**Calculated Stress, σ (MPa)**	**Calculated Strain ε**
0	0	-	-	-	0	0
500	1.56	-	16181	16993	3.1	0.061
1000	1.79	-	16092	17128	6.2	0.070
1500	1.96	-	15891	17299	9.3	0.077
2000	2.13	-	15763	17383	12.4	0.083
2500	2.3	-	15807	17391	15.5	0.090
3000	2.48	-	15883	17448	18.6	0.097
3500	2.67	-	15991	17496	21.7	0.105
4000	2.89	-	16113	17598	24.8	0.113
4500	3.15	-	16248	17687	27.9	0.124
5000	3.45	-	16291	17781	31	0.135
5500	3.87	-	16380	17799	34.1	0.152
5850		Specimen break			36.27	Specimen break

Calculations-

$$\text{Stress, } \sigma = \frac{\text{Load (P)}}{\text{Area (A)}}$$

Area (A) = Length X Thickness

Where, Width =12.7 mm Thickness = 12.7 mm

Area (A) = 161.29 mm^2

For example, for serial no. 3 of Table,

$$\sigma = \frac{1000}{161.29} = 6.2 \text{ MPa}$$

$$\text{Strain } \varepsilon = \frac{\text{Elongation (P)}}{\text{Gauge length (L)}}$$

For example, for serial no. 3 of Table,

$$\varepsilon = \frac{1.79}{25.4} = 0.07$$

Stress at break point for **Composite 1 = 36.27 MPa** which may be seen in table 1.

The graphical representation of above analysis as stress strain diagram is shown in figure 2

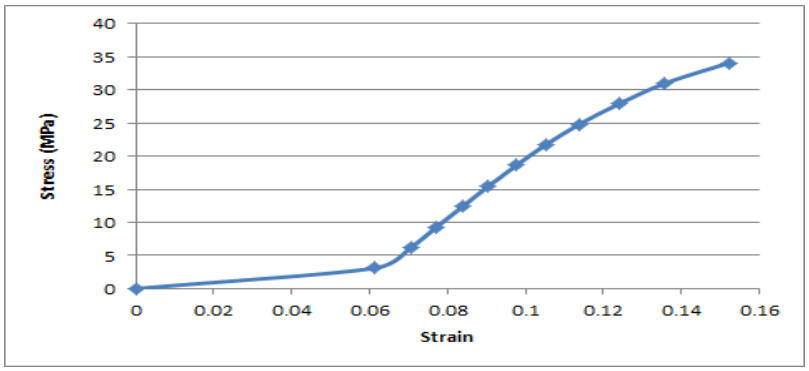

Fig 2 Stress-Strain curve for Composite 1

Now the same test is also performed on both of the remaining composites and the observations are noted for comparison and properties evaluation. According to the test, observed value of stresses at break point for **Composite 2** and **Composite 3** are as **38.78 MPa** and **40.54 MPa** respectively. The composite 1 comes out as the best composition on strength point of view.

III. RESULT AND DISCUSSION

Here we fabricated the two materials in appropriate % of their requirement. We added suitable % of human hair in polypropylene and obtained three composites to test for comparison and properties evaluation. Composite 1 having 3% human hair and 97% polypropylene, Composite 2 with 5% human hair and 95% polypropylene and Composite 3 having 8% human hair and 92% polypropylene. And further we gone for properties evaluation and comparison test as compressive strength. With less % of human hair the strength of composites are not so good then this % is slightly increased and an increment in strength is also observed. We further increased some more % of human hair and now achieved the best results for properties evaluation as compressive strength. The best composition is obtained in form of Composite 3 as it holds best value of compressive stress as 40.54 MPa till break point.

The comparison among the composites for their compressive strength using stress-strain diagram is shown in figure 3.

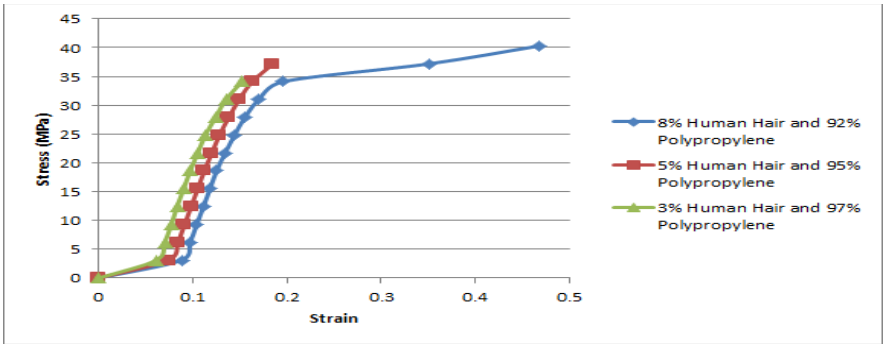

Fig 3 Comparison among the composites during compression test using stress- strain diagram

From figure 3 it is clearly shown that the strength of composite 3 having 8% human hair and 92% polypropylene is highest as it's (blue line) crosses the Stress line above 40 MPa.

IV. CONCLUSION

The present paper goes with the two essential works as fabrication of composites with the help of injection moulding process and after that comparison and properties evaluation of obtained composites respectively and observed favorable results. The result completely justifies the specified work as strength rises with raised % of human hair in polypropylene. The best result we achieved with Composite 3 which is having 8% human hair and 92% polypropylene and holds the value **40.54 MPa** as compressive strength. Hence we can say that human hair fibre reinforces the polypropylene matrix and enhances the properties for which it is incorporated.

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